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Age comparisons of capelin otoliths by Norwegian and Russian age readers 2004-2007 – a review

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Introduction and background

Experts from the two labs IMR in Bergen and PINRO in Murmansk met for the first time in 1984 to discuss age determination of capelin. It was concluded that no systematic differences existed between the labs (Gjøsæter, 1985). Analyses during the following years showed that during the joint autumn surveys there were, seemingly, small differences between the age readings on the different participating vessels. On the other hand, judged from catch-at-age data reported to the ICES Northern Pelagic and Blue Whiting Working Group from the winter capelin fishery in the years following the fishing moratorium 1994-1998 and from scientific surveys during the winter-spring period, large discrepancies were found, which could not be attributed to differences in length. Normally, PINRO reported higher ages than IMR. To check the presence of systematic differences between the otolith readers at the two laboratories and to study the reasons for such differences, a capelin otolith workshop was organised and hosted by PINRO in autumn 1999 (Gjøsæter and Ushakov, 2000). During that workshop it was decided to start an otolith exchange program and to organise biannual workshops. After the third Workshop in October 2003, a report was made to sum up the results and conclusions from the otolith exchange program and the three workshops (Gjøsæter et al., 2003). The main findings were that a better agreement was reached on otoliths from the autumn season than from the winter season, and that there was an improvement over the period of otolith exchange. In most cases, almost full agreement (> 95%) among all readers was reached for autumn otoliths during recent years. The variation among readers was very small for otoliths with modal age 2 and 3, while those with modal age 4 caused some more variation. It was concluded that so far, "there does not seem to be any systematic differences between the age readings of capelin at PINRO and IMR. However, to monitor possible changes in this situation, the labs will continue to exchange otoliths according to established procedures. Workshops will be organized every second year, as part of the quality assurance of age reading of capelin."

Since then, the program of otolith exchange and biannual workshops has continued, and the present report gives an update of results obtained since 2003.

Material and methods

Three experts from PINRO (Elena Tereschenko, Rima Maslova, and Tatyana Prokhorova and three from IMR (Bente Røttingen, Jan Henrik Nilsen and Jaime Alvarez) have read most of the otoliths during the interchange and during the two workshops in 2005 and 2007. Capelin researchers Dmitry Prozorkevich, Nikolay Ushakov (PINRO) and Harald Gjøsæter (IMR) also read some otoliths, and participated in the analysis of the results. All the otoliths were prepared according to Norwegian standard procedures, which means that the otoliths were embedded in the mounting medium Entelan®. The results were recorded on standard spreadsheets for otolith reading comparisons (Eltink, 2000) and were analysed according to the guidelines in Eltink *et al.*, (2000).

Exchange program

Period	Norwegian otoliths	Russian otoliths
Winter 2004	50	100
Autumn 2004	50	100
Winter 2005	50	
Workshop 2005	185	175
Autumn 2005	50	90
Winter 2006	50	
Autumn 2006	50	170
Winter 2007	50	50
Workshop 2007	205	150

Results

The degree of agreement among readers are shown in Table 1 for all otoliths read. For those samples where some or all otoliths that were read differently by at least one reader were discussed and where some readers changed their opinion as a result of that discussion, a second column called "after correction" are shown. It is seen that the per cent agreement ((number age readers disagreeing with the modal age of the otolith)*100) is generally high (at average 93%). In only 8 of 36 samples were the agreement less than 90%.

The analysis spreadsheet (Eltink, 2000) contains numerous tables, figures and tests, which can be used to scrutinise various aspects of the age reading comparisons (Eltink et al., 2000). However, for a crude overview, the table depicting inter-reader bias and the plots of each reader's results compared to the median results have been found to be useful. To avoid a large number of figures, these two entities are shown for two samples from each year, one from the winter season and one from the autumn season. The samples to present were picked at random from the total number of comparisons.

There has been a substantial improvement in the agreement on age reading during the period of otolith exchange and workshops. There is now what could be called "full agreement" on otoliths from the autumn season, which means that the inter-reader variability in each lab is very small, but as large as that between laboratories.

Conclusions

It is concluded that there does not seem to be any systematic differences between the age readings of capelin at PINRO and IMR. This result is, at least partly, comes from the ongoing otolith exchange program and the regular otolith workshops organised by the two laboratories. However, to monitor possible changes in this situation, and to prevent that differences in age

reading in capelin might develop, the labs will continue to exchange otoliths according to established procedures. Workshops will be organized every second year, as part of the quality assurance of age reading of capelin.

Reference list

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Gjøsæter, H. 1985. Report of the otolith workshop. Pp.233-236 in: Gjøsæter, H. (ed.):The Procedings of the Soviet-Norwegian Symposium on The Barents Sea Capelin., Bergen, Norway, Institute of Marine Research.

Gjøsæter, H., Maslova, R., Prokhorova, T., Prozorkevich, D., Røttingen, B., Nilsen, J.H., Tereshchenko, E. and Ushakov, N. 2003. Age comparisons of capelin otoliths by Norwegian and Russian age readers 1999-2003 – a review. IMR/PINRO Joint Report Series, No. 3/2003. ISSN 1502-8828. 17 pp.

Table 1. Summary of results of otolith reading comparison 2004-2007.

Season	Country	Serial number	N otoliths	Percent agreement	
				Before corr.	After corr.
Winter 2004	Norway	70357	50	92.7	
Winter 2004	Russia	sample 6	50	93.5	
Winter 2004	Russia	sample 14	50	91.9	
Autumn 2004	Norway	2566	50	97.3	
Autumn 2004	Russia	tr. 131	50	96.7	
Autumn 2004	Russia	tr. 276	50	100.0	
Autumn 2004	Russia	np 74	50	80.4	
Autumn 2004	Russia	np 67	25	79.6	
Winter 2005	Norway	70127	50	91.8	
Winter 2005	Norway	70373	25	97.1	
Winter 2005	Norway	70134	50	87.3	94.3
Winter 2005	Norway	70084	50	85.6	90.9
Winter 2005	Norway	70442	50	89.7	92.5
Winter 2005	Norway	70121	10	100.0	
Winter 2005	Russia	sample 5	50	91.7	
Winter 2005	Russia	sample 3	50	91.3	
Autumn 2005	Norway	2906	50	95.1	96.2
Autumn 2005	Russia	sample36	25	91.1	91.6
Autumn 2005	Russia	sample 42	25	87.6	88.4
Autumn 2005	Russia	sample 46	40	100.0	
Winter 2006	Norway	70086	50	90.2	91.1
Autumn 2006	Norway	2769	50	97.3	
Autumn 2006	Russia	tr. 194	25	98.7	
Autumn 2006	Russia	sample 10	25	84.9	87.1
Autumn 2006	Russia	sample 43	20	97.2	
Autumn 2006	Russia	sample 34	50	97.8	
Winter 2007	Norway	70033	50	94.3	94.5
Winter 2007	Norway	71016	30	93.3	93.8
Winter 2007	Norway	70067	20	100.0	
Winter 2007	Norway	70053	25	98.5	
Winter 2007	Norway	70305	50	86.8	89.3
Winter 2007	Russia	s 1	50	88.4	90.0
Autumn 2007	Norway	2782	30	98.3	
Autumn 2007	Norway	2854	50	97.8	
Autumn 2007	Russia	sample37	50	97.8	
Autumn 2007	Russia	sample 41	50	92.3	93.0
Autumn 2007	Russia	sample 40	50	93.8	94.0
Total number of otoliths compared			1525		
Average agreement between readers				93.2	

Inter-reader bias test and reader against MODAL age bias test

	N BR	N JHN	N JA	N HG	R LT	R RM	R DP	R NU	R TP
	Reader 1	Reader 2	Reader3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9
Reader 1		—	—	*	—	*	—	**	—
Reader 2			—	*	—	*	—	**	—
Reader3				—	—	—	—	—	—
Reader 4					—	—	*	—	—
Reader 5						—	—	*	—
Reader 6							*	—	*
Reader 7								**	—
Reader 8									*
Reader 9									
MODAL age	—	—	—	—	—	—	—	*	—

—	= no sign of bias (p>0.05)
*	= possibility of bias (0.01<p<0.05)
* *	= certainty of bias (p<0.01)

Figure 1. Norwegian otoliths from winter 2004 inter reader bias.

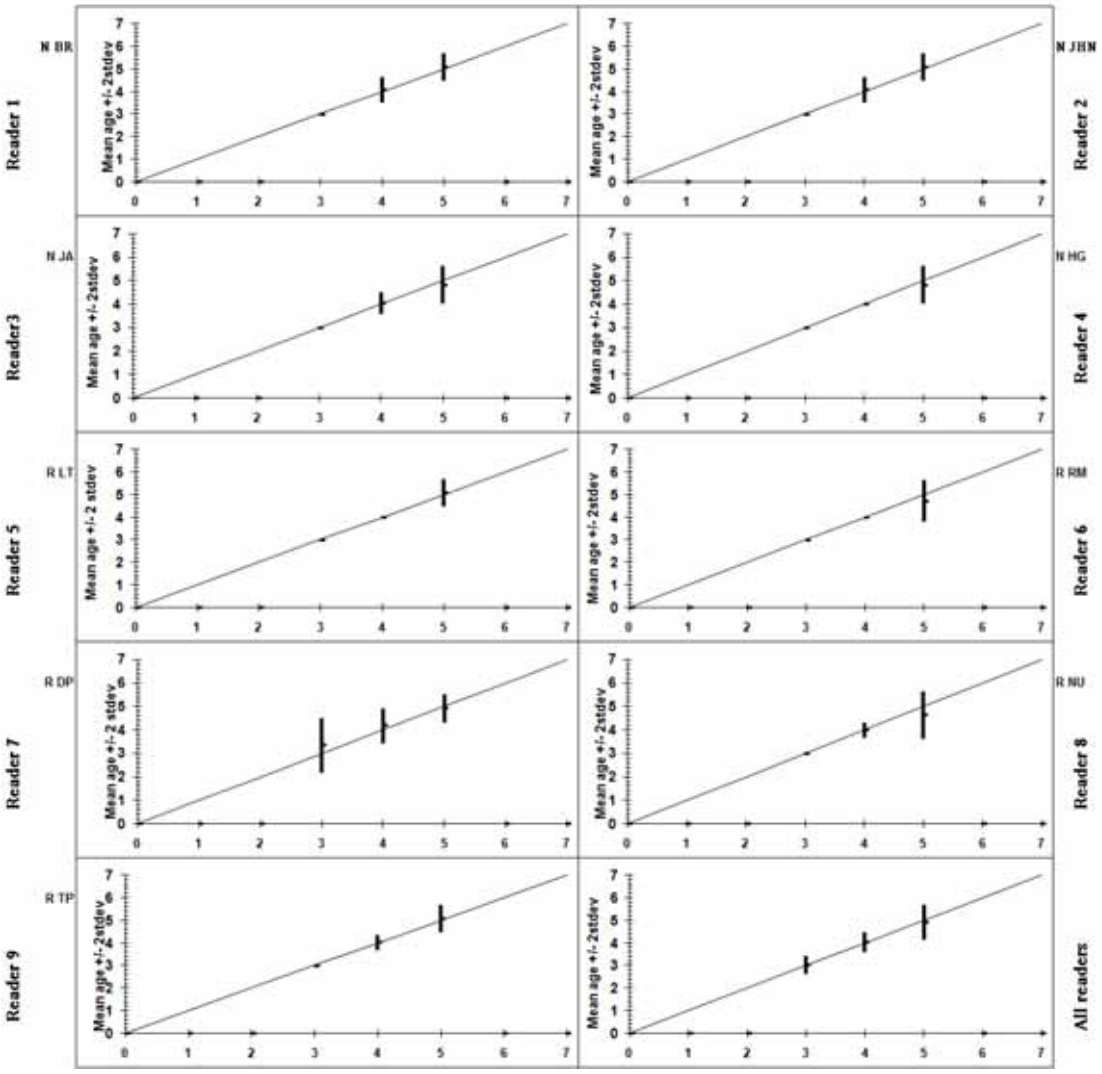

Figure 2. Norwegian otoliths from winter 2004 age bias plots. The mean age recorded +/- 2stdev of each age reader and all readers combined are plotted against the MODAL age. The estimated mean age corresponds to MODAL age, if the estimated mean age is on the 1:1 equilibrium line (solid line). RELATIVE bias is the age difference between estimated mean age and MODAL age.

Inter-reader bias test and reader against MODAL age bias test

	N BR	N JHN	N JA	N HG	R LT	R RM	R DP	R NU	R TP
	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9
Reader 1		—	—	—	—	—	—	—	—
Reader 2			—	—	—	—	—	—	—
Reader 3				—	—	—	—	—	—
Reader 4					—	—	—	—	—
Reader 5						—	—	—	—
Reader 6							—	—	—
Reader 7								—	—
Reader 8									—
Reader 9									
MODAL age	—	—	—	—	—	—	—	—	—

—	= no sign of bias (p>0.05)
*	= possibility of bias (0.01<p<0.05)
* *	= certainty of bias (p<0.01)

Figure 3. Russian otoliths from autumn 2004 inter reader bias.

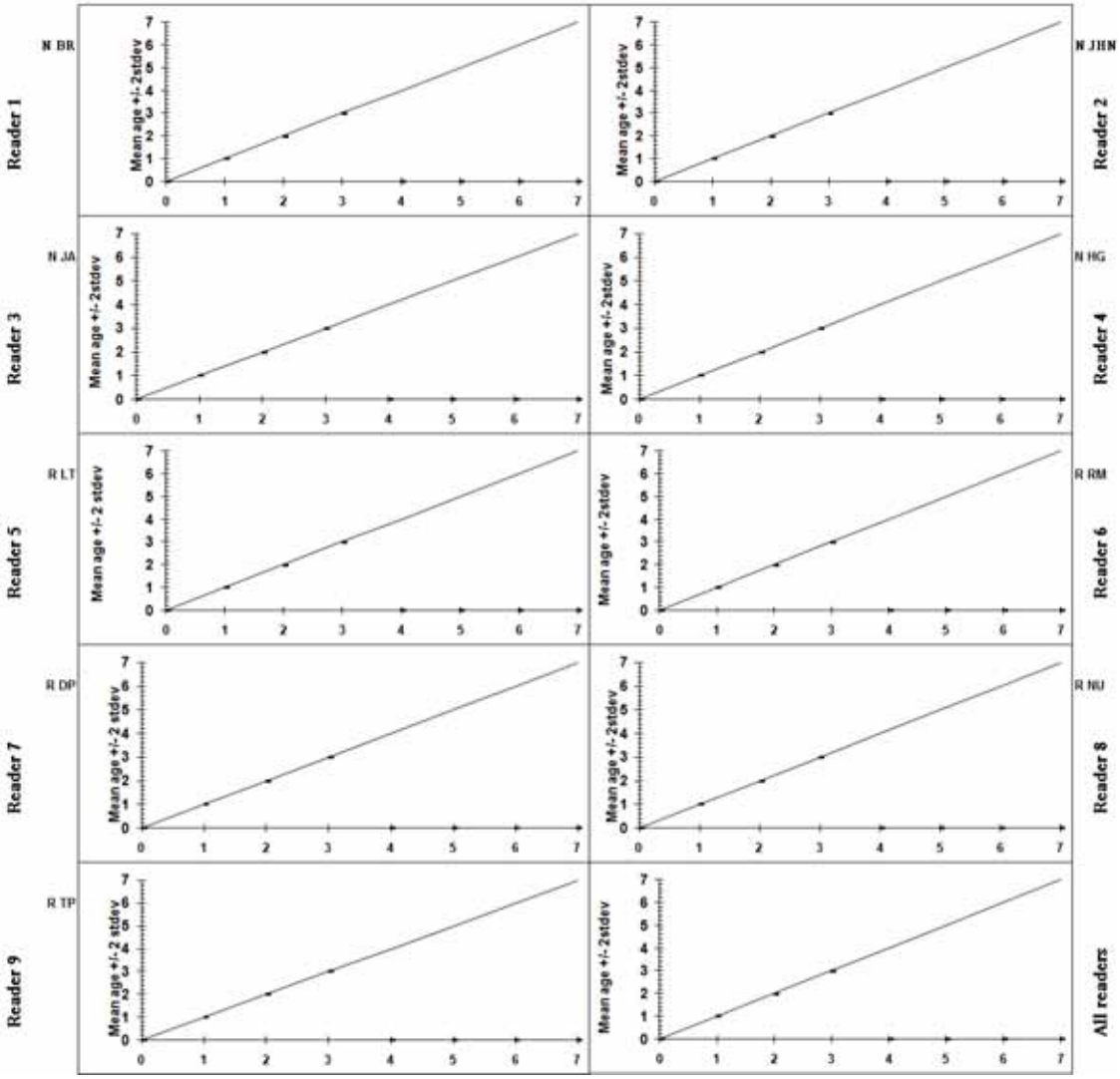

Figure 4. Russian otoliths from winter 2004 age bias plots. The mean age recorded +/- 2stdev of each age reader and all readers combined are plotted against the MODAL age. The estimated mean age corresponds to MODAL age, if the estimated mean age is on the 1:1 equilibrium line (solid line). RELATIVE bias is the age difference between estimated mean age and MODAL age.

Inter-reader bias test and reader against MODAL age bias test

	N BR	N JHN	N JA	N HG	R LT	R RM	R DP	R NU	R TP
	Reader 1	Reader 2	Reader3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9
Reader 1		—	—		—		—		—
Reader 2			—		—		—		—
Reader3					—		—		—
Reader 4									
Reader 5							—		—
Reader 6									
Reader 7									—
Reader 8									
Reader 9									
MODAL age		—	—		—		—		—

—	= no sign of bias (p>0.05)
*	= possibility of bias (0.01<p<0.05)
* *	= certainty of bias (p<0.01)

Figure 5. Russian otoliths from winter 2005 inter reader bias.

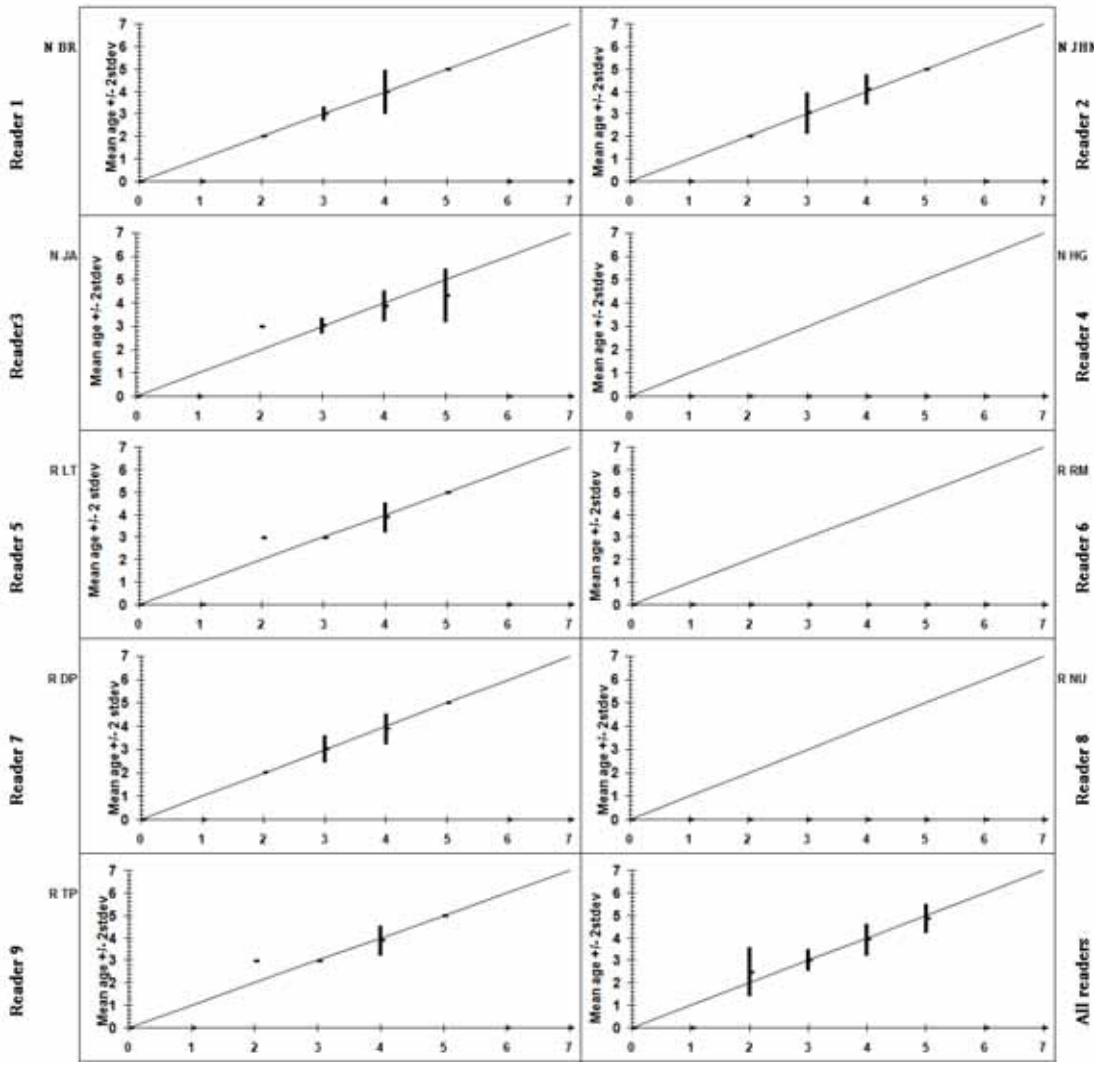

Figure 6. Russian otoliths from winter 2005 age bias plots. The mean age recorded +/- 2stdev of each age reader and all readers combined are plotted against the MODAL age. The estimated mean age corresponds to MODAL age, if the estimated mean age is on the 1:1 equilibrium line (solid line). RELATIVE bias is the age difference between estimated mean age and MODAL age.

Inter-reader bias test and reader against MODAL age bias test

	N BR	N JHN	N JA	N HG	R LT	R RM	R DP	R NU	R TP
	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9
Reader 1		—	—	—	—	—	—	—	—
Reader 2			—	—	—	—	—	—	—
Reader 3				—	—	—	—	—	—
Reader 4					—	—	—	—	—
Reader 5						—	—	—	—
Reader 6							—	—	—
Reader 7								—	—
Reader 8									—
Reader 9									
MODAL age	—	—	—	—	—	—	—	—	—

—	= no sign of bias (p>0.05)
*	= possibility of bias (0.01<p<0.05)
* *	= certainty of bias (p<0.01)

Figure 7. Norwegian otoliths from autumn 2005 inter reader bias.

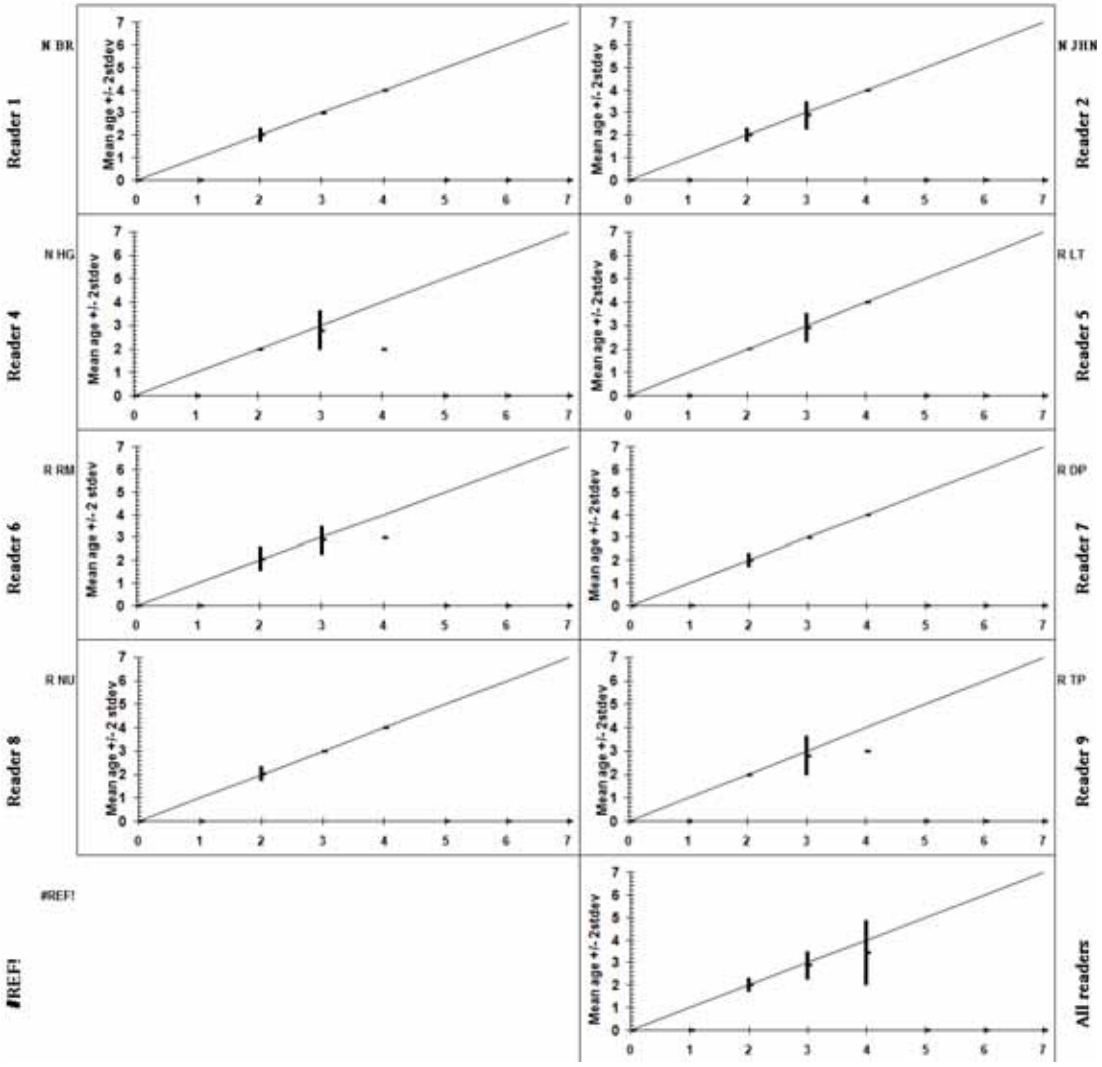

Figure 8. Norwegian otoliths from autumn 2005 age bias plots. The mean age recorded +/- 2stdev of each age reader and all readers combined are plotted against the MODAL age. The estimated mean age corresponds to MODAL age, if the estimated mean age is on the 1:1 equilibrium line (solid line). RELATIVE bias is the age difference between estimated mean age and MODAL age.

Inter-reader bias test and reader against MODAL age bias test

	N BR	N JHN	N JA	N HG	R LT	R RM	R DP	R NU	R TP
	Reader 1	Reader 2	Reader3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9
Reader 1		—	—	—	—	—	—	—	—
Reader 2			—	*	—	**	—	—	—
Reader3				—	—	—	—	—	—
Reader 4					—	—	—	—	—
Reader 5						—	—	—	—
Reader 6							*	—	—
Reader 7								—	*
Reader 8									—
Reader 9									
MODAL age	—	—	—	—	—	—	—	—	—

—	= no sign of bias (p>0.05)
*	= possibility of bias (0.01<p<0.05)
* *	= certainty of bias (p<0.01)

Figure 9. Norwegian otoliths from winter 2006 inter reader bias.

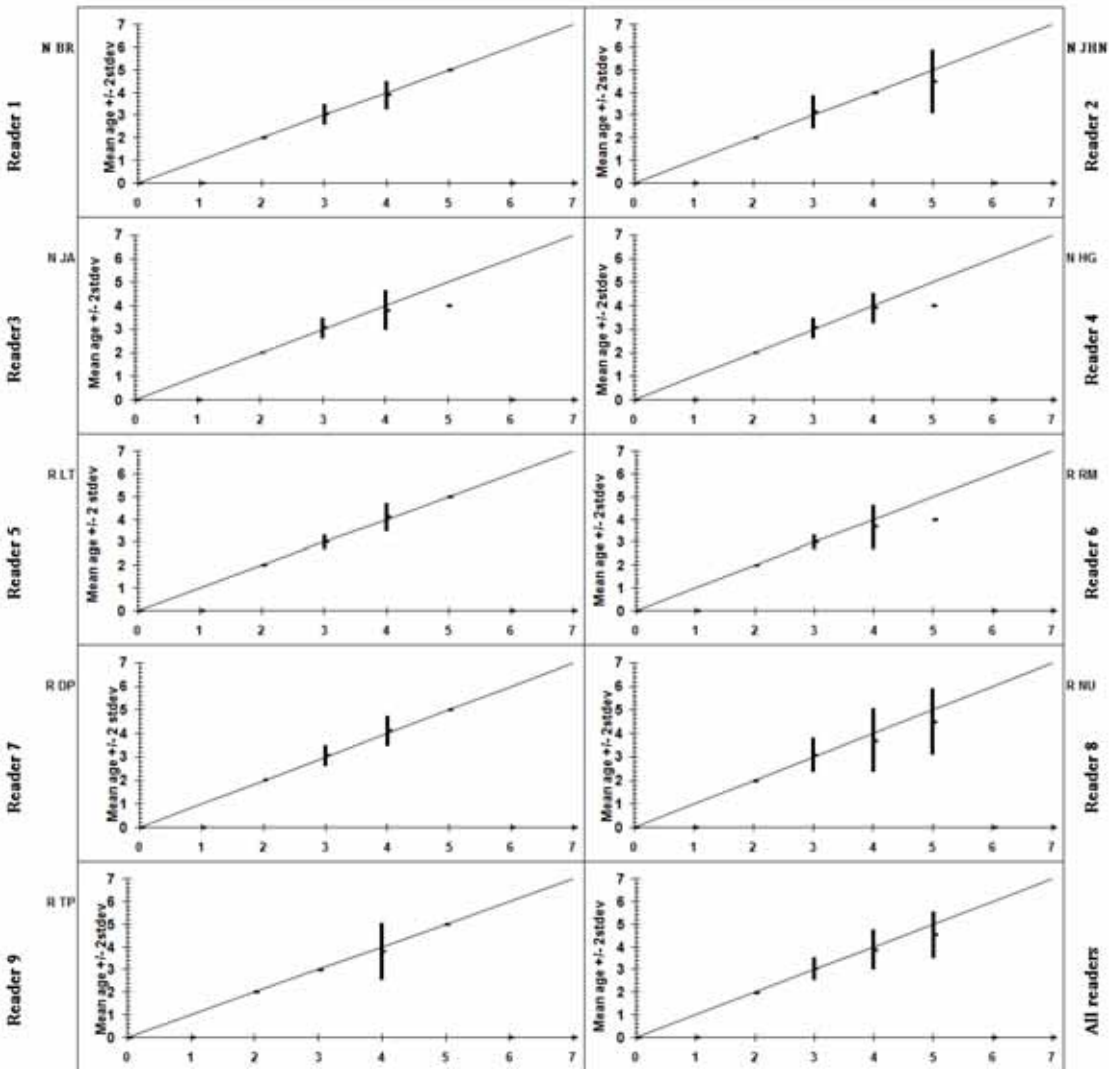

Figure 10. Norwegian otoliths from winter 2006 age bias plots. The mean age recorded +/- 2stdev of each age reader and all readers combined are plotted against the MODAL age. The estimated mean age corresponds to MODAL age, if the estimated mean age is on the 1:1 equilibrium line (solid line). RELATIVE bias is the age difference between estimated mean age and MODAL age.

Inter-reader bias test and reader against MODAL age bias test

	N BR Reader 1	N JHN Reader 2	N JA Reader3	N HG Reader 4	R LT Reader 5	R RM Reader 6	R DP Reader 7	R NU Reader 8	R TP Reader 9
Reader 1		—	—	—	—	—	—	—	—
Reader 2			—	—	—	—	—	—	—
Reader3				—	—	—	—	—	—
Reader 4					—	—	—	—	—
Reader 5						—	—	—	—
Reader 6							—	—	—
Reader 7								—	—
Reader 8									—
Reader 9									
MODAL age	—	—	—	—	—	—	—	—	—

—	= no sign of bias (p>0.05)
*	= possibility of bias (0.01<p<0.05)
* *	= certainty of bias (p<0.01)

Figure 11. Russian otoliths from autumn 2006 inter reader bias.

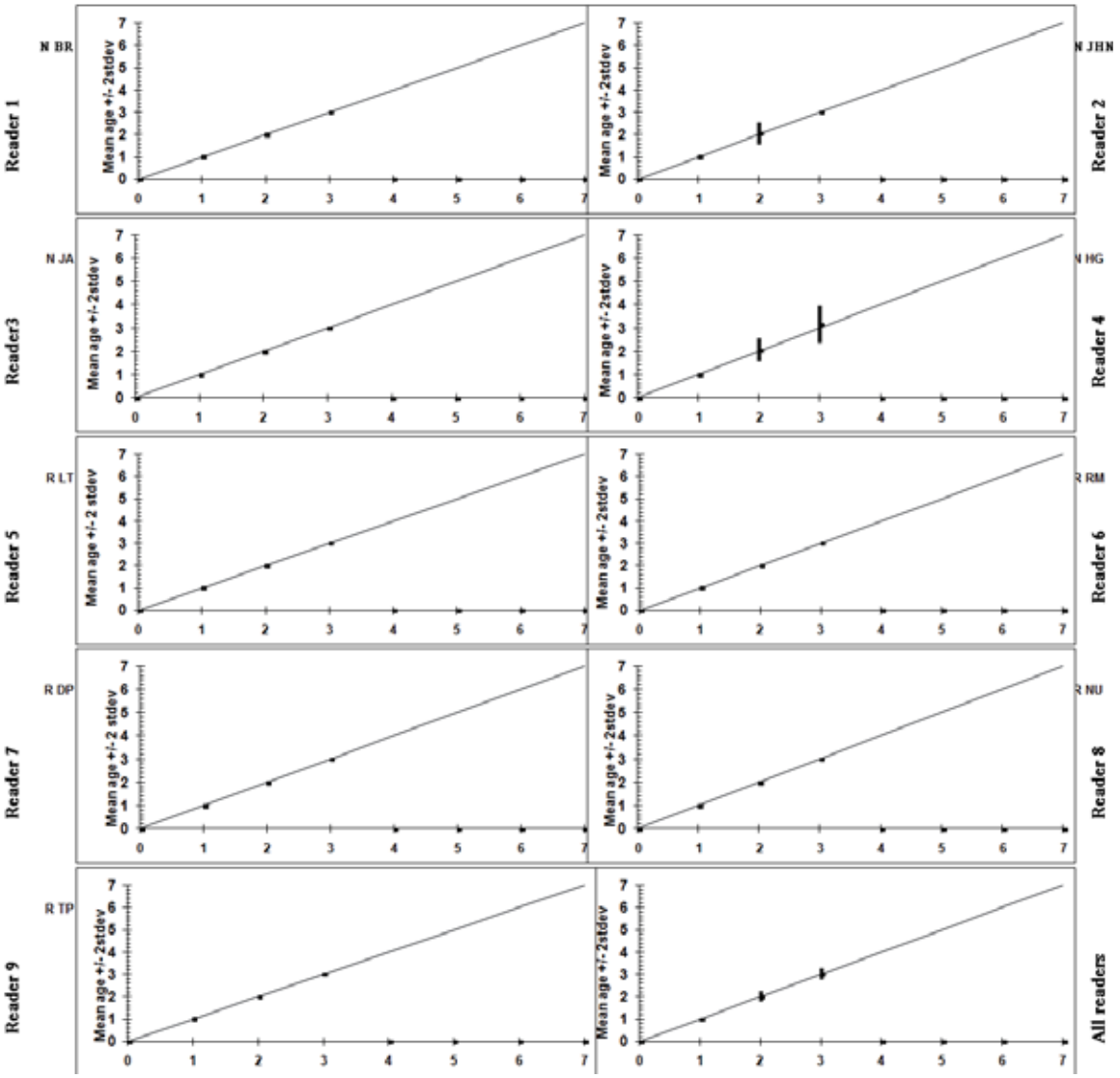

Figure 12. Russian otoliths from autumn 2006 age bias plots. The mean age recorded +/- 2stdev of each age reader and all readers combined are plotted against the MODAL age. The estimated mean age corresponds to MODAL age, if the estimated mean age is on the 1:1 equilibrium line (solid line). RELATIVE bias is the age difference between estimated mean age and MODAL age.

Inter-reader bias test and reader against MODAL age bias test

	N BR Reader 1	N JHN Reader 2	N JA Reader3	N HG Reader 4	R LT Reader 5	R RM Reader 6	R DP Reader 7	R NU Reader 8	R TP Reader 9
Reader 1			*	—	*	—	—	—	—
Reader 2									
Reader3				—	**	*	—	—	**
Reader 4					*	—	—	—	—
Reader 5						—	*	*	—
Reader 6							—	—	—
Reader 7								—	—
Reader 8									—
Reader 9									
MODAL age	—		*	—	*	—	—	—	—

—	= no sign of bias (p>0.05)
*	= possibility of bias (0.01<p<0.05)
**	= certainty of bias (p<0.01)

Figure 13. Norwegian otoliths from winter 2007 inter reader bias.

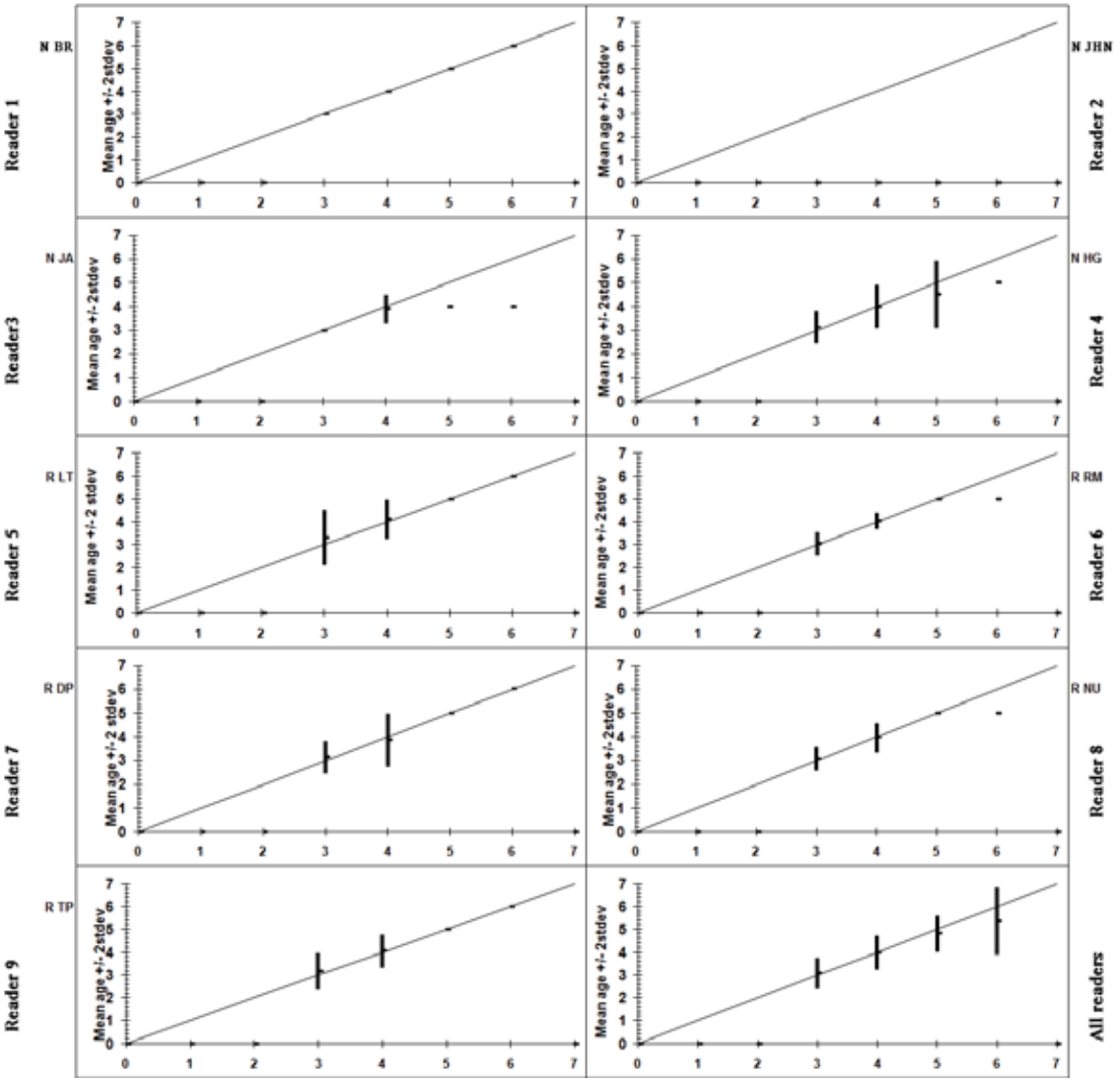

Figure 14. Norwegian otoliths from winter 2007 age bias plots. The mean age recorded +/- 2stdev of each age reader and all readers combined are plotted against the MODAL age. The estimated mean age corresponds to MODAL age, if the estimated mean age is on the 1:1 equilibrium line (solid line). RELATIVE bias is the age difference between estimated mean age and MODAL age.

Inter-reader bias test and reader against MODAL age bias test

	N BR	N JHN	N JA	N HG	R LT	R RM	R DP	R NU	R TP
	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9
Reader 1			**	—	—	—	—	—	—
Reader 2									
Reader 3				*	**	**	*	*	**
Reader 4					—	—	—	—	—
Reader 5						—	—	—	—
Reader 6							—	—	—
Reader 7								—	—
Reader 8									—
Reader 9									
MODAL age	—		**	—	—	—	—	—	—

—	= no sign of bias (p>0.05)
*	= possibility of bias (0.01<p<0.05)
* *	= certainty of bias (p<0.01)

Figure 15. Russian otoliths from autumn 2007 inter reader bias.

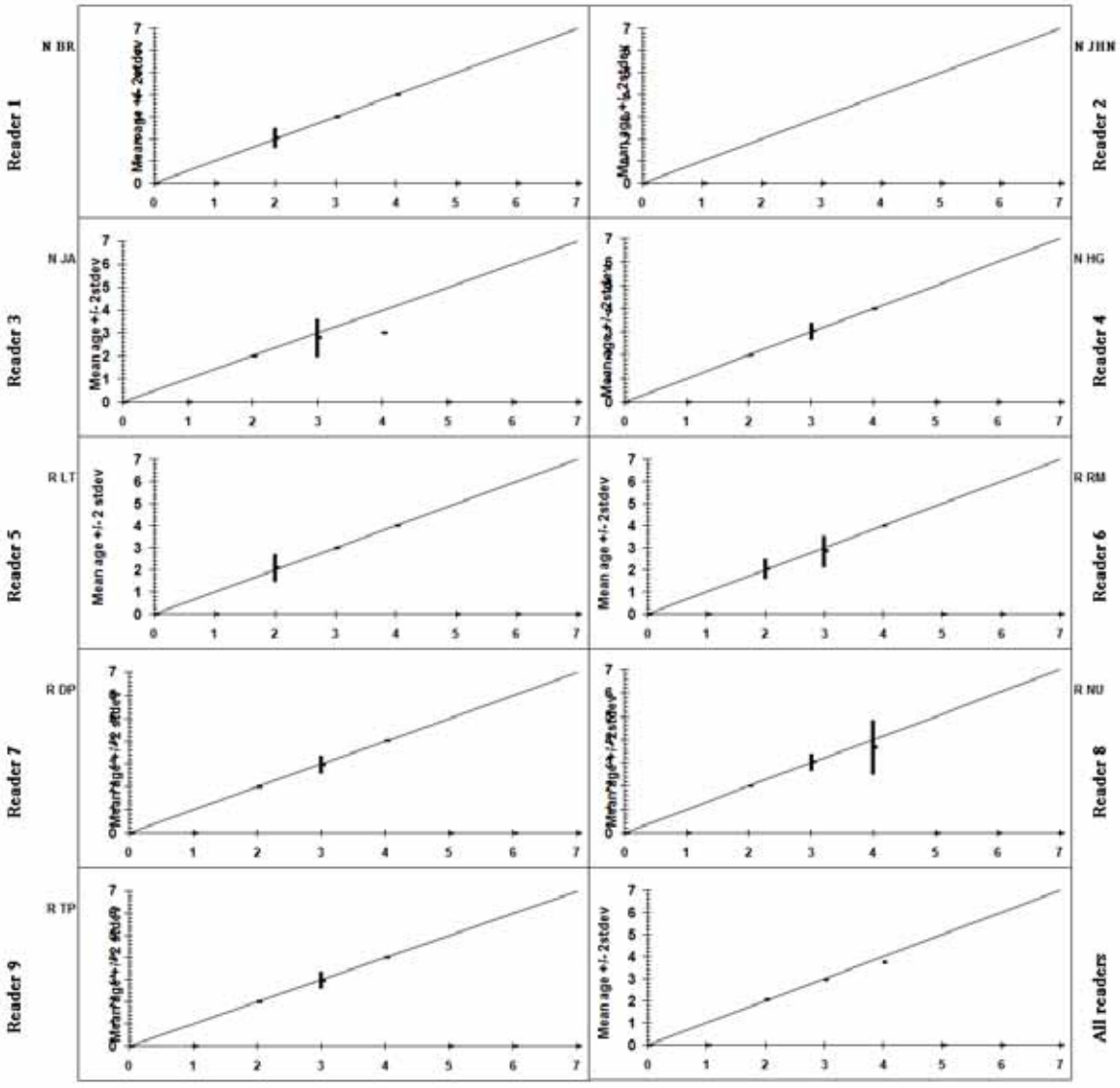

Figure 16. Russian otoliths from autumn 2007 age bias plots. The mean age recorded +/- 2stdev of each age reader and all readers combined are plotted against the MODAL age. The estimated mean age corresponds to MODAL age, if the estimated mean age is on the 1:1 equilibrium line (solid line). RELATIVE bias is the age difference between estimated mean age and MODAL age.

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REPORT